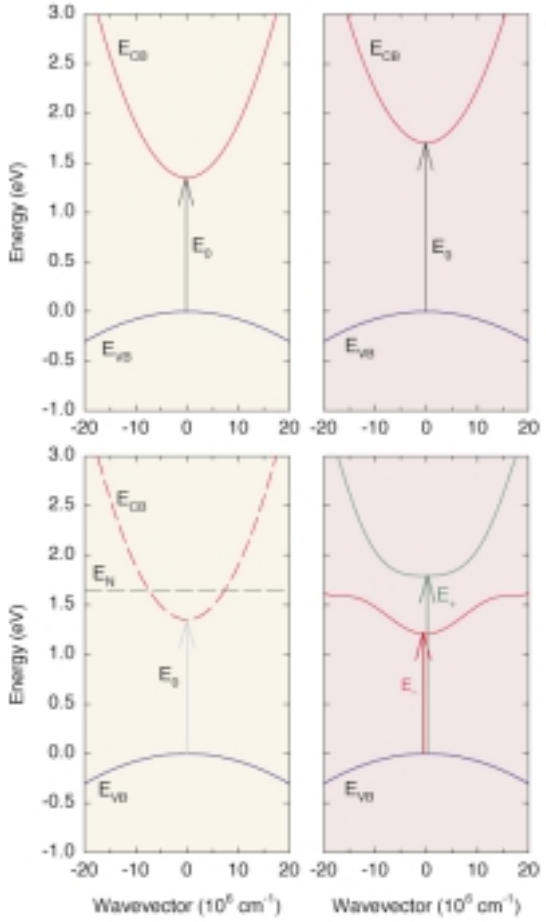
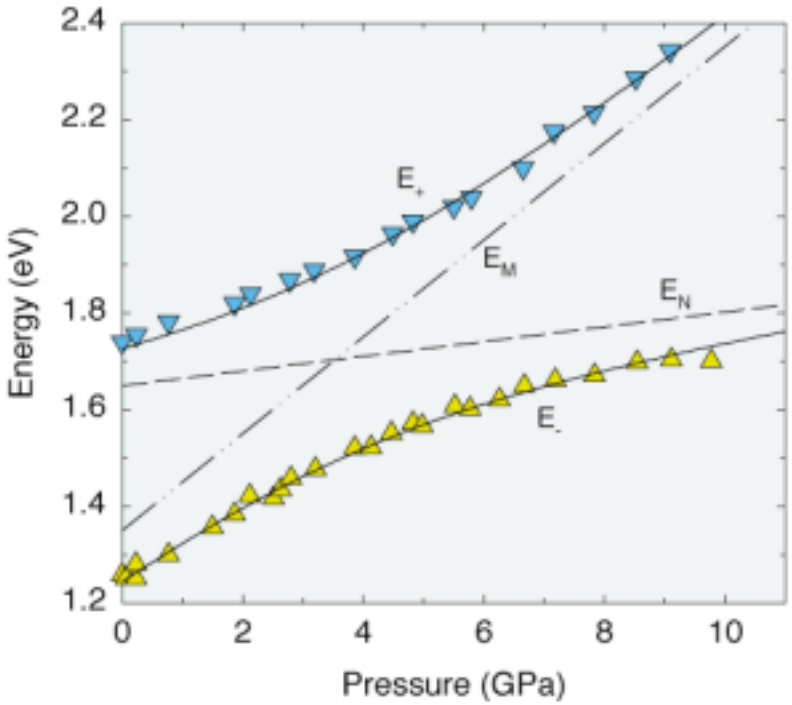
Anomalous Electronic Behavior of Semiconductor Alloy Explained

"Anti-Crossing" Shown to Be Responsible for Reduction of Bandgap



Ordinary alloy semiconductor (top). Addition of smaller constituent reduces lattice constant, raising conduction band and lowering valence band, leading to an increase in the bandgap E_0. GaAsN (bottom). Electrons from the "localized" state at E_N undergo a repulsive interaction with the conduction band states, forcing the conduction band edge states lower in energy. Nitrogen-like states are modified to form a second conduction band state, which is pushed up in energy. Two optical transitions from the valence band, E_+ and E_- are predicted and observed.



The dotted lines are the expected hydrostatic pressure dependence of the GaInAs conduction band (E_M) and the localized nitrogen level (E_N) in the absence of an interaction. Optical measurements of the actual pressure dependence (triangles) show that the two levels interact and "repel" each other. The "anti-crossing" model (solid lines) is in excellent agreement with experiment, showing that the repulsive interaction is responsible for the downward shift of the bandgap in GaInAsN and GaAsN alloys.

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